RESEARCH PROBLEM STATEMENT

Problem Title: Dynamic Passive Pressure on Abutments & Pile Caps

No.: 05.07-3 (also 05.08-3)

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1. Briefly describe the problem to be addressed:

Various design recommendations are given for the passive force-deflection relationships for abutments and pile caps. Research suggests that resistance is substantially greater and that current recommendations are leading to costly increases in the number of piles to handle lateral load. Current UDOT specs. call for only 3 ft of compacted backfill around bent pile caps, but it is unknown how this will reduce the passive resistance relative to complete backfill. Various pile cap connections are presently used but very little guidance is available to define how these connections affect ultimate resistance and load-deflection relationships. Finally, most design recommendations ignore increased resistance due to damping which could also lead to greater economy. Full-scale dynamic tests can provide answers to these design issues and lead to significant cost savings. Testing equipment and personnel will be mobilized to Utah from California during summers 2005 and 2006 for a related study funded by NSF and can greatly reduce the cost of testing.

Strategic Goal: ☐ Preservation ☒ Operation ☐ Capacity ☒ Safety (Check all that apply)

2. List the research objective(s) to be accomplished:

1. Develop passive force-deflection relationships for dynamic loads

2. Determine effect of pile cap connection details on abutment stiffness.

3. Evaluate damping coefficients for pile caps and backfills.

3. List the major tasks required to accomplish the research objective(s): **Estimated person-hours**

1. Construct pile caps for testing which have different width/height ratios and connection details (varying from "pinned" to "fixed").
2. Perform static and dynamic lateral load test on pile caps without backfill. (Static tests with 1300 kip actuators and dynamic tests with 100 kip eccentric mass shakers)
3. Evaluate stiffness-rotation relationship for pile caps with different connection details.
4. Perform static and dynamic lateral load tests on pile caps with compacted backfill extending three distances from the face.
5. Conduct analysis of test results to define static and dynamic passive force-displacement relationships and damping ratios for partial and complete compacted backfill cases.
6. Evaluate existing methods and recommend improvements to account for measured response.
7. Prepare final report with implementation summary.

4. Outline the proposed schedule (when do you need this done, and how we will get there):

Large eccentric mass shakers and personnel from UCLA will be in Utah in late summer 2005 and summer 2006 and can be used for these tests without mob/demob costs or major personnel time charges. The success of the project will hinge on coordinating with the availability of this equipment. Coordination will also be necessary to obtain supplemental funding from other DOTs. Ideally, the work would begin in May 2005. All field testing would be completed by mid-summer 2006. Analysis of test data would likely require six to eight months and a report would be completed at the end of the second year.

5. Indicate type of research and / or development project this is:

Large: ☒ Research Project ☐ Development Project
Small: ☐ Research Evaluation ☐ Experimental Feature ☐ New Product Evaluation ☐ Tech Transfer Initiative : ☐ Other_____

6. What type of entity is best suited to perform this project (University, Consultant, UDOT Staff, Other Agency, Other)?

University with supervision and oversight by UDOT staff as part of technical advisory committee.

7. What deliverable(s) would you like to receive at the end of the project? (e.g. useable technical product, design method, technique, training, workshops, report, manual of practice, policy, procedure, specification, standard, software, hardware, equipment, training tool, etc.) A report will be prepared describing the results of the field testing and the analysis of the test data. The report will also contain an implementation summary which will concisely describe the design methods developed from the field testing and provide an example of its use for a typical problem. Design recommendations for pile head connections will be provided. Results from the study will also be presented to the AASHTO bridge design technical committee on foundations for adoption in future AASHTO codes.

8. Describe how this project be implemented at UDOT.

The equations developed would be used in the design of new bridges and retrofit of old bridges by the structural and geotechnical engineers. Presentations on the use of the method will need to be provided by the researchers and a report will be available to UDOT consultants.

9. Describe how UDOT will benefit from the implementation of this project, and who the beneficiaries will be.

By accurately accounting for dynamic passive resistance, pile foundations can be more efficiently designed which will reduce the number of piles, the size of pile caps, and the overall cost of bridge structures. In addition, the resulting structures will have increased safety against earthquake damage. Potential cost savings of pile foundations could be in the 20-40% range. There are also potential cost savings in the superstructure design.

10. Describe the expected risks, obstacles, and strategies to overcome these.

The costs associated with this project are relatively high but other state DOT's have expressed willingness to participate in a pooled fund project, thereby leveraging the cost to UDOT. Final commitment will require recruitment by UDOT and university personnel. The testing cost can be minimized if performed in summer 2005 and summer 2006 when 200 k capacity eccentric mass shakers from UCLA will already be mobilized to Salt Lake for related field testing.

11. List the key UDOT Champion of this project (person who will help Research steer and lead this project, and will participate in implementation of the results): Jon Bischoff, Hugh Boyle, Darin Sjoblom

12. Estimate the cost of this research study including implementation effort (use person-hours from No. 3): $75k UDOT; $125k others

13. List other champions (UDOT and non-UDOT) who are interested in and willing to participate in the Technical Advisory Committee for this study:

Name	Organization/Division/Region	Phone	Attended UTRAC?
A) Jon Bischoff	Structural Geotechnical Section/UDOT/Complex	965-4326	Yes
B) Hugh Boyle	Structural Design Group/UDOT/Complex	965-4517	Yes
C) Darin Sjoblom	Structural Geotechnical Section/UDOT/Complex	964-4474	Yes
D) Kyle Rollins	Civil & Environ. Engineering/BYU	422-6334	Yes
E) Travis Gerber	Civil & Environ. Engineering/BYU	422-1439	Yes
F) Marv Halling	Civil & Environ. Engineering/USU	435 797-3179	Yes
G)			

14. Identify other Utah agencies, regional or national agencies, or other groups that may have an interest in supporting this study:

Caltrans, NYDOT, Illinois DOT, Oregon DOT